

CLAIMS

1. An acoustic mirror type thin film bulk acoustic resonator comprising:

5 a substrate;

an acoustic mirror layer provided on the substrate, including a plurality of impedance layers alternately having a high acoustic impedance and a low acoustic impedance; and

10 a piezoelectric thin film vibrator provided on the acoustic mirror layer, including a lower electrode, a piezoelectric thin film and an upper electrode,

wherein the sum of a thickness of the lower electrode and a thickness of the upper electrode is 5% or more and 60% or less of a whole thickness of the piezoelectric thin film vibrator, and
15 the thickness of the lower electrode is larger than the thickness of the upper electrode.

2. The thin film bulk acoustic resonator according to claim 1, wherein the plurality of impedance layers includes a
20 plurality of low acoustic impedance layers and a plurality of high acoustic impedance layers which are alternately disposed, and

an uppermost one of the low acoustic impedance layers which contacts the lower electrode, has a thickness of one fourth of an acoustic wavelength defined from a resonant frequency in free
25 space of the piezoelectric thin film vibrator.

3. The thin film bulk acoustic resonator according to claim 2, wherein each of the plurality of low acoustic impedance layers has a thickness of one fourth of the acoustic wavelength defined from the resonant frequency in free space of the piezoelectric thin film vibrator.

4. The thin film bulk acoustic resonator according to claim 1, wherein the plurality of impedance layers includes a plurality of low acoustic impedance layers and a plurality of high acoustic impedance layers which are alternately disposed, and an uppermost one of the low acoustic impedance layers which contacts the lower electrode, has a thickness of less than one fourth of an acoustic wavelength defined from a resonant frequency in free space of the piezoelectric thin film vibrator.

5. The thin film bulk acoustic resonator according to claim 4, wherein each of the plurality of low acoustic impedance layers has a thickness of less than one fourth of the acoustic wavelength defined from the resonant frequency in free space of the piezoelectric thin film vibrator.

6. The thin film bulk acoustic resonator according to claim 1, wherein the plurality of impedance layers includes a plurality of low acoustic impedance layers and a plurality of high

acoustic impedance layers which are alternately disposed, and
an uppermost one of the low acoustic impedance layers which
contacts the lower electrode, has a thickness of more than one
fourth of an acoustic wavelength defined from a resonant frequency
5 in free space of the piezoelectric thin film vibrator.

7. The thin film bulk acoustic resonator according to
claim 6, wherein each of the plurality of low acoustic impedance
layers has a thickness of more than one fourth of the acoustic
10 wavelength defined from the resonant frequency in free space of
the piezoelectric thin film vibrator.

8. The thin film bulk acoustic resonator according to
claim 1, wherein the plurality of impedance layers includes a
15 plurality of low acoustic impedance layers and a plurality of high
acoustic impedance layers which are alternately disposed, and
at least an uppermost one of the plurality of low acoustic
impedance layer, has a thickness different from one fourth of an
acoustic wavelength defined from a resonant frequency in free space
20 of the piezoelectric thin film vibrator, and

an uppermost one of the high acoustic impedance layers has
a thickness different from one fourth of the acoustic wavelength
defined from the resonant frequency in free space of the
piezoelectric thin film vibrator.

9. The thin film bulk acoustic resonator according to claim 8, wherein each of the plurality of high acoustic impedance layers has a thickness different from one fourth of the acoustic wavelength defined from the resonant frequency in free space of the piezoelectric thin film vibrator.

10. A filter comprising two or more thin film bulk acoustic resonators which are connected in a ladder form, wherein at least one of the thin film bulk acoustic resonators comprises:

a substrate;

an acoustic mirror layer provided on the substrate, including a plurality of impedance layers alternately having a high acoustic impedance and a low acoustic impedance; and

a piezoelectric thin film vibrator provided on the acoustic mirror layer, including a lower electrode, a piezoelectric thin film and an upper electrode,

wherein the sum of a thickness of the lower electrode and a thickness of the upper electrode is 5% or more and 60% or less of a whole thickness of the piezoelectric thin film vibrator, and the thickness of the lower electrode is larger than the thickness of the upper electrode.

11. A duplexer comprising a transmission filter and a reception filter, wherein

at least one of the transmission filter and the reception filter comprises two or more thin film bulk acoustic resonators which are connected in a ladder form, and

at least one of the thin film bulk acoustic resonators
5 comprises:

a substrate;

an acoustic mirror layer provided on the substrate, including a plurality of impedance layers alternately having a high acoustic impedance and a low acoustic impedance; and

10 a piezoelectric thin film vibrator provided on the acoustic mirror layer, including a lower electrode, a piezoelectric thin film and an upper electrode,

wherein the sum of a thickness of the lower electrode and a thickness of the upper electrode is 5% or more and 60% or
15 less of a whole thickness of the piezoelectric thin film vibrator, and the thickness of the lower electrode is larger than the thickness of the upper electrode.

12. A communication apparatus comprising at least one thin
20 film bulk acoustic resonator, wherein

the at least one thin film bulk acoustic resonators
comprises:

a substrate;

an acoustic mirror layer provided on the substrate,
25 including a plurality of impedance layers alternately having a

high acoustic impedance and a low acoustic impedance; and

a piezoelectric thin film vibrator provided on the acoustic mirror layer, including a lower electrode, a piezoelectric thin film and an upper electrode,

- 5 wherein the sum of a thickness of the lower electrode and a thickness of the upper electrode is 5% or more and 60% or less of a whole thickness of the piezoelectric thin film vibrator, and the thickness of the lower electrode is larger than the thickness of the upper electrode.